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Bridging the "Valley of Death": A DoD/FFRDC Partnership to Accelerate low-TRL, Commercial Space Technology for Military Programs

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Bridging the "Valley of Death": A DoD/FFRDC Partnership to Accelerate low-TRL, Commercial Space Technology for Military Programs

Andre Doumitt—The Aerospace Corporation

Ben Bycroft—The Aerospace Corporation

Mat Bissonnette—The Aerospace Corporation

Oskari Vakki—The Aerospace Corporation

Ian Stern—The Aerospace Corporation

Tom Heinsheimer—The Aerospace Corporation

Marcus Bracey—AFRL/SpaceWERX

Abstract

The Department of Defense (DoD) has historically been challenged to integrate commercial technology into major acquisition programs, particularly from small businesses and non-traditional defense contractors. Traditional procurement processes, lengthy development timelines, and stringent requirements have often created barriers for innovative companies seeking to contribute to national security efforts. Within the Space Force, these challenges are further amplified by the rapid pace of commercial space advancements, which often outstrip the traditionally slow and complex defense acquisition cycles. As a result, cutting-edge technologies developed by commercial industry remain underutilized, limiting the DoD's ability to leverage the full potential of the United States (U.S.) innovation ecosystem. To address this gap, a structured and repeatable process is needed to systematically assess, mature, and transition emerging technologies into defense applications. The Technology Readiness Level (TRL) Bootcamp provides a scalable solution designed to accelerate the adoption of commercial space technologies by streamlining technical evaluation and providing mission-driven analysis and targeted testing, thereby increasing the probability that high-potential innovations can be rapidly integrated into operational defense programs.

Introduction

Due to a changing international competitive posture in the space environment, the United States risks losing its position as the preeminent global space power. To maintain that position, it's imperative that the United States maximizes the total breadth of its innovation and industrial power. Unfortunately, there are numerous obstacles to achieving that vision.

One such challenge is that the U.S. Space Force program managers in charge of major programs such as GPS and MILSATCOM are frequently deluged with commercial tech companies marketing a range of products and services. Due to their breadth and variety, understanding their actual level of technical maturity, and what additional time and resources it will take to achieve program readiness, is often far from clear. Worse, to capture new business, small businesses often represent their technical maturity as higher than it actually is. As a result, such companies are often seen as "risky," and program managers can be disincentivized from engaging and selecting such companies for Government programs. The results are damaging and include an inability to efficiently leverage innovation from the U.S. industrial base, missed opportunities to leverage commercial investment, a widened opportunity gap for small companies, and reduced international competitiveness for the United States vis-à-vis rival powers.

Research into methods for transitioning non-traditional, commercial space technology into U.S. Space Force programs resulted in the establishment of a pilot project dubbed “TRL Bootcamp,” initiated in March 2024 (Air Force Research Laboratory [AFRL], 2024). The TRL Bootcamp, sponsored by SpaceWERX in partnership with The Aerospace Corporation, began as a program to guide promising technologies through the “Valley of Death,” the challenging transition phase that small businesses often face between receiving initial funding through Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) contract awards and achieving full product readiness or commercialization. The pilot TRL Bootcamp was designed to support SpaceWERX's (2022) Orbital Prime program, which concentrated on developing technology for in-space servicing, assembly, and manufacturing (ISAM) and dynamic space operations (DSO).

To achieve the desired outcomes, the TRL Bootcamp provides a framework to rapidly accelerate the TRL of selected technologies. The approach calls for an initial rigorous maturity assessment of a given technology within a mission concept of operations (CONOPS). Next, the program provides specific analyses and testing designed to quickly mature the technology on a path to transitioning into a program of record. This is followed by a public/private partnership wherein Government and national lab assets are leveraged to actually perform the recommended testing, after which the technology is given its new maturity rating. The authors postulate that establishing a system that rigorously assesses technical maturity against a target mission CONOPS, paired with providing access to laboratory test equipment at Government and national labs, is an achievable and scalable method for better leveraging the innovation and industrial strength of the U.S. commercial sector and can result in more efficient exploitation of the U.S. industrial base for military effectiveness and international competition.

The Challenge of Transitioning Commercial Space Technology to Military Applications a Changing Military and Economic Competitive Environment

Impact on Military Competitiveness

Today, space is critical to virtually all aspects of our society. From military operations to civilian applications and economic drivers like banking and finance, space is a critical link to the functioning of our civilization. It has also become an Achilles heel. Failure to robustly integrate commercial technology into the space domain creates substantial economic and strategic risk, making our nation vulnerable to competitors and adversaries alike. Threats to space assets are now very real and include direct ascent anti-satellite missiles as well as co-orbital attacks and non-physical attacks such as cyber-attacks, jamming and blinding satellites with lasers. A report from the Center for Strategic and International Studies (2024) notes that *“China’s first ASAT launch in 2007, then its geosynchronous ASAT launch in 2013, prove that China is perfecting kill shots.”* It goes on to point out that Russia resumed its ASAT testing in 2021 after a decades-long pause, giving the world a highly bellicose demonstration just before invading Ukraine. These examples, including India’s successful ASAT test in 2019, prove that the space domain is no longer beyond the reach of war. The international techno-economic environment has also changed from what was a superpower face-off between the United States and the Soviet Union to now 77 countries around the world with space programs, including 16 countries with launch capability (Space Insider, 2023).

Consequently, a robust, whole-of-nation approach that combines commercial and Government space capabilities may be our best approach to addressing an increasingly dangerous space domain and new economic competitors here on Earth. To that point, a report by the National Security Space Association (2022) strongly urges that immediate attention be given to “*more effectively leveraging the commercial space sector’s investments, technology, know-how, goods, and services to enhance defense and intelligence space activities.*” Other

authors emphasize the same point, including U.S. Space Command (2024), which notes, "*Commercial capabilities and services support Government, civil, and commercial space architectures in peacetime and potentially provide additional capacity to meet military requirements in crisis and conflict.*" Finally, the RAND Corporation (2023a) points out that "*Commercial space services can provide additional capacity and resilience to existing space capabilities or provide new ones.*" The report goes on to cite potentially impactful commercial contributions to space-based Positioning, Navigation, and Timing (PNT) signal strength and accuracy, SATCOM throughput latency, coverage and jam resistance, and how a variety of services from multiple commercial providers brings resiliency through dissimilar vulnerabilities.

The Commercial Funding Hockey Stick

Research by Bryce Space indicates that in the 10 years from 2000–2009 there was $2 billion of private capital invested into space technology, for an average of $200 million/year (Bryce Tech, 2019, p. 14). By contrast, for the period 2009 through 2024, research from Space Capital (2024) shows equity investment reached a cumulative $338.7 billion, or $2.1 billion/year, a 1,000% average annual increase over the previous period (p. 19). This is tremendous growth and precisely the investment the Government would like to leverage for its space programs.

Startup Mortality & the "*Valley of De-Orbits*"

Startups are exciting, but they experience high mortality as they struggle to bridge the gap between product development and market traction. Despite dramatic private sector investment in space technology, research by the Bureau of Labor Statistics (BLS, n.d.) indicates nearly half of all startups fail by year five. There are many reasons for this, which go beyond the scope of this paper, but research indicates that lack of product-market fit (see Figure 1) may be the single largest factor in startup failure, at 34% in one study (Failory, n.d.). For space startups, who need to capture both Government and commercial contracts for survival, the failure rates are likely higher, but aren't tracked separately by the BLS. The Government space sector presents significant barriers to entry. These include long, complex procurement processes; funding gaps between R&D and full scale deployment; lack of clear transition pathways; high cost of Government-specific compliance and security requirements; challenges competing against large, established prime contractors; and critical risk aversion in DoD acquisition (GAO, 2022; Congressional Research Service, 2023). Any single factor, and certainly all of them together, present significant entry barriers to DoD programs for small companies. The barriers can create a kind of "Valley of De-orbits" that limits how much commercial technology investment can be transitioned into Government space programs, and by extension, the extent to which the United States can leverage its full industrial base for military and commercial competitiveness on the world stage.

This paper focuses primarily on one particular entry barrier to the DoD acquisition: risk aversion. This approach will break down aspects of risk aversion and propose a path forward. Ultimately, the goal is to accelerate the transition of small business space technology into Government programs.

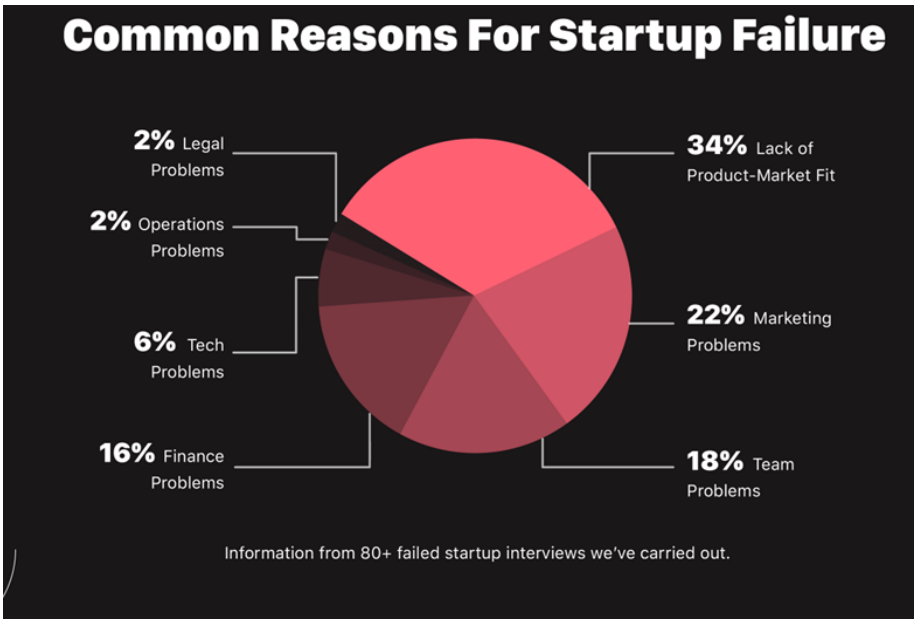

Figure 1. Common Reasons for Startup Failure

Risk Aversion in DoD Acquisition - Technical & Business

In its 2024 report entitled *Aligning Incentives to Drive Faster Tech Adoption*, the Defense Innovation Board writes "*the Department of Defense … has a systemic aversion to risk and a lack of urgency that has led to a culture of sustaining the status quo. This environment is characterized by a preference for familiar solutions and partnerships, often at the expense of exploring potentially superior, albeit riskier, new technologies*" (p. 10). The core of this is simple: people do what works. This means working with large defense contractors who have largely proven their ability to deliver on large, complex government programs. The incentive structure for government program managers strongly reinforces this, since pay and promotions are built around delivering large programs on cost and schedule. In this context, ideas like "innovation," "startups," and "emerging technology" sound like a *threat* to cost and schedule.

Risk aversion can comprise aversion to both technical and business risk. For technical risk, program managers worry—consciously or unconsciously—about three kinds of technical risk: the maturity of the technology being proposed (is it baked, and will it work as advertised), will it successfully integrate into my technical environment (will it work for *me*), and will it scale (will it work *across* my programs and networks). That said, if the technical maturity is deemed to be too low or simply isn't clear, integration and scaling won't be considered.

The second risk is business: If a program manager is comfortable with the technical risks, the idea that a startup has at least a 50% chance of being out of business after 5 years can be an obstacle. Program managers focus on cost and schedule, and large, established brands don't bring the existential risk common to small businesses. Big companies have established supply chains, existing regulatory compliance, proposal teams, a history of delivering, and are not likely to suddenly go out of business. Given their size and integration into the defense ecosystem, large defense primes likely have numerous personal relationships with the government customer as well, further cozying the dynamic.

This is the context facing many government program managers, many of whom are excited by the wave of innovation washing over the space industry but struggle to reconcile that with the systems and incentives governing their programs and careers. In this environment, another obstacle is simply "data overload," where program managers are overwhelmed by a

flood of commercial companies, all clamoring for attention and loudly attesting that their solution is the perfect fit for whatever program is on offer, but nearly universally lacking business and technical validation. This entire issue, including technical and business risk, is neatly encapsulated in the phrase "*Nobody ever got fired for buying from IBM,*" which you will occasionally still hear and is at the root of the risk aversion preventing the full exploitation of commercial innovation.

Limited Opportunities to Demonstrate Operational Capability

There's an old adage in the space community that says "*you can't fly in space until you've flown in space.*" This tongue-in-cheek point means that space systems only gain full confidence after they've attained space heritage. At the same time, there's a recognition that there are insufficient opportunities for emerging technologies to perform demonstrations, testing and integration to access space, especially when it comes to working with DoD systems and architectures. This is essentially a barrier to entry, as most government programs have extensive testing and certification requirements before integration is permitted onto the system,[1] and small businesses are unlikely to be able to self-fund the flight test and certification costs.

Thus, despite the recent proliferation of various Government "innovation" programs designed to nurture innovation, testing and demonstration options remain few. As noted in a recent RAND publication, "*Most Defense Innovation Organizations do not have the funding required to sponsor larger-scale live-fire exercises themselves; they can, however, advocate to include specific technologies or products in a live exercise run by an operational component*" (The RAND Corporation, 2023, p. 51). We are starting to see exactly this emerge, with the recent addition of several SpaceWERX portfolio companies participating in the INDOPACOM Northern Edge exercise focused on demonstrating alternative PNT. In this context, below we will discuss our emphasis on Concept of Operations (CONOPS) in the context of TRL assessment, and touch on some emerging approaches to emulating mission environments that begin to address the lack of demonstrations, testing and integration opportunities on DoD systems.

ITRL Bootcamp: A Systematic Approach to Accelerating Technology Transition

In the prior section, we discussed three kinds of technical risk, maturity, integration and scaling, which limit acquisition of innovative technology. In practice, we don't really consider integration and scaling if there is no confidence in *current* technical maturity or its ability to grow on a predictable timeline. This is the core priority we address with the program called "TRL Bootcamp." This program was designed to help bridge the 'valley of death' by providing a structured, mission-driven framework for technology maturation and transition. The TRL Bootcamp process will be introduced below, followed by an overview of the program as executed to date.

The TRL Bootcamp Process

Step 1: Onboarding Technology Readiness Assessment

A core tenet of TRL Bootcamp is to evaluate and support the acceleration of a technology's readiness in the context of CONOPS relevant to USSF mission needs. Approaching the evaluation of these technologies in this way helps identify mismatches between the development path for a company and the intended mission needs driving requests for proposals and development in time to adjust and refine. Independent evaluation of TRL is performed following the NASA (n.d.) *Technology Readiness Assessment Best Practices Guide*,

[1] As an example, Space Force Instruction 13-604 providing *Guidance and Procedures on System Acceptance Throughout the Space Force* (U.S. Space Force, 2023)

which goes far beyond the high level TRL bullet points or 'thermometer graphic' which most new entrants to space technologies encounter when prompted to self-assess TRL. These best practices detail the fidelity to which core technology elements have been demonstrated, analyzed, and/or tested as well as the degree to which system integration, mission requirements, and environments are understood and verified in order to meet each TRL level. An independent evaluation performed by trained assessors avoids the challenges of self-reported TRL by ensuring adherence to the detailed guidance for TRL definitions rather than flexible interpretation of high level TRL summaries. This problem was highlighted when studying the technologies being developed under the Orbital Prime program where 40% of TRL self-assessments were at least two or more levels higher than when evaluated by an independent, trained assessor. This process also ensures that the CONOPS tied to the TRL is a match for USSF mission needs and is at a level of maturity matching the technology's development which ranges from a generic class of missions at early TRLs up to a specific mission at higher TRLs.

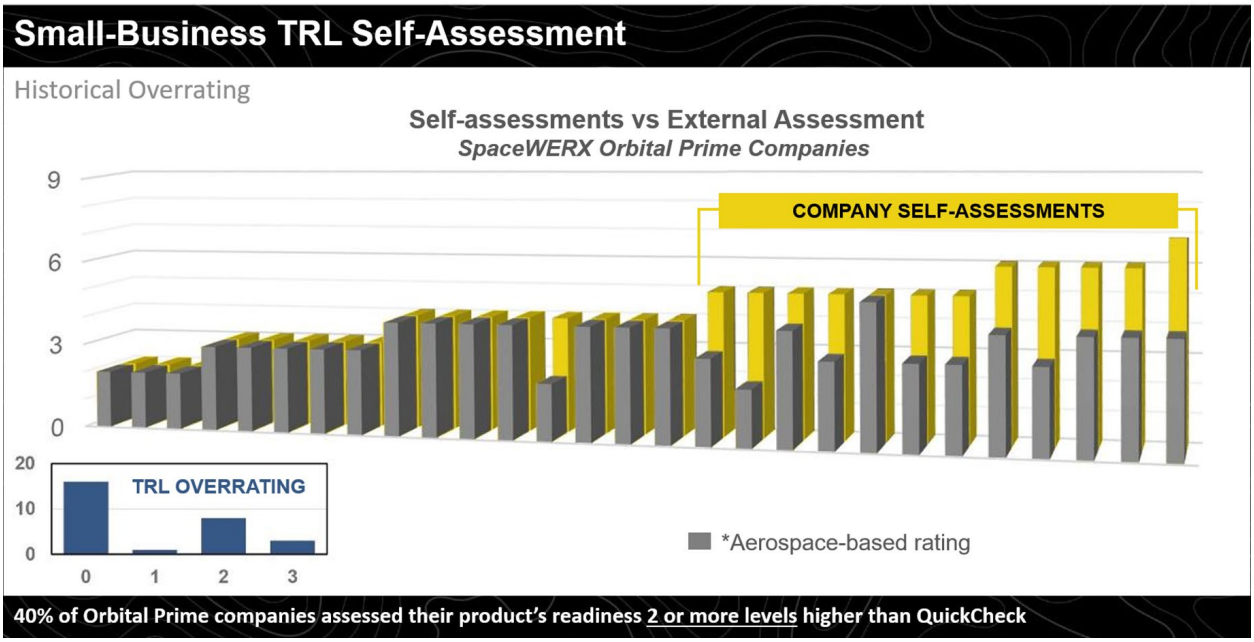

Figure 2. Small Business TRL Self-Assessment

The primary goal for this TRL assessment is to identify the gaps in CONOPS maturity, performance or function demonstrations, and fidelity of analysis or a test preventing a technology from reaching the next TRL. These gaps are used to recommend prioritized efforts to companies in the TRL Bootcamp and to identify complementary support from subject matter experts, modeling and simulation capabilities, and test facilities accessible through the program. The assessment also allows early identification of integration challenges and potentially mismatched environment expectations which are common among new entrants to space technologies.

Step 2: Tailored Support Engagement and Recommendations

Companies taking part in TRL Bootcamp span the full breadth of non-traditional defense contractors, ranging from lean teams of deep experts with novel technology to businesses positioning themselves to become a new era of prime integrators and growing a full complement of staff and skill sets. Similarly, these companies may be staffed by engineers who have flown countless technologies in space or teams looking to apply their expertise from other domains and approaching the challenges of transitioning technologies to space for the first time. In this

phase of the program, the gaps identified by TRL evaluation are used to form TRL-raising recommendations tailored to the company's staff and facilities. Where gaps exist which require external support, public-private partnerships are coordinated and leveraged to offer paths to analysis, modeling and simulation, and test capabilities which may otherwise be out of reach for a small business or unknown to a non-traditional defense contractor.

The program connects small businesses with Government and national laboratories and attempts to streamline access to critical subject matter expertise, capabilities, and testing facilities. Identifying and, when able, providing this access allows companies to more efficiently use Government contracts to mature their technologies by bolstering their core competencies with support to fill critical gaps to the next TRL. This approach encourages not only a focus on efforts truly necessary to prepare a technology for transition, but provides pathways to reach these goals without extending existing staff beyond their expertise or levying expectations of the breadth of skill sets and facilities of a prime contractor onto a small business. With priority gaps to the next TRL and external support to complement a small business's competencies, the degree of engagement during the subsequent laboratory phase of TRL Bootcamp is tailored to match the needs.

Step 3: TRL Bootcamp Laboratory Phase

Given priority TRL gaps and the recommendations and support identified in the prior steps, engagement during the Laboratory Phase of TRL Bootcamp falls into several categories. For companies with technologies in early formulation or CONOPS refinement phases (TRL 1-3), or conversely who have good coverage of capabilities needed to close gaps, TRL Bootcamp may engage in an advisory "phone a friend" capacity. Companies may request consultation with experts with space domain and/or targeted technical expertise but perform analysis and test using their own resources. In cases of technologies further in development (TRL 3-4) with gaps that fall outside the capabilities of a small business, TRL Bootcamp works to provide support in these areas for analysis, integration with modeling or simulation capabilities, or targeted hardware testing to verify individual parameters of performance, function, or build. For more mature technologies (TRL 4-6), TRL Bootcamp attempts to provide advanced integrated test opportunities by pairing companies with testbeds and proving grounds meant to mimic relevant environments or operational scenarios for a technology. These opportunities are intended to demonstrate not only individual properties of a technology, but its ability to integrate with a system and perform its function in simulated or emulated operational contexts. Technologies preparing for integration with specific missions and flight (TRL 7-9) are more likely to have facilities related to the mission Systems they will integrate with for testing. In these cases, TRL Bootcamp may engage in advisory support to provide recommendations to effectively utilize these test opportunities or aid in analysis and recommendations based on results.

Step 4: Offboarding Technology Readiness Assessment

Upon completion of the TRL Bootcamp, a revised TRL assessment is performed to include progress made by the company and provided by external support as part of the program. This revised TRL assessment is provided to companies not only to identify progress made during the program but to identify the new priority gaps to achieve the next TRL. Companies may then leverage this offboarding assessment to prioritize their future development of their technology, as well as approaching future funding or transition opportunities with an independent evaluation of their TRL.

Preliminary Outcomes From the TRL Bootcamp Pilot

TRL Bootcamp Program Execution

TRL Bootcamp is a program funded by the U.S. Space Force's SpaceWERX program office. In its current format, companies are eligible after having been awarded a SBIR or STTR Phase II contract and been selected by a combination of SpaceWERX and its partner USSF program office for the topic in development. For the initial TRL Bootcamp program, a 9-month pilot was launched in March 2024 with companies from Orbital Prime, a space technology investment program which sought to accelerate transition of technologies for In-Space Servicing, Assembly, and Manufacturing (ISAM) as well as Active Debris Remediation (ADR). Orbital Prime started with 120 Phase I STTR awards and progressed to 50 SBIR/STTR Phase II awards as follow-on efforts. Seven companies from the subsequent Phase II cohort of performers entered the inaugural TRL Bootcamp and brought technologies ranging from individual payload mechanisms meant for ISAM and ADR applications up to entire in-space infrastructure concepts, each with novel elements and a determined team looking to make an impact on USSF's mission needs. As noted in a concurrent Air Force Research Lab press release, "TRL Bootcamp … gives SpaceWERX partners access to Aerospace Corporation's 100,000 square-foot laboratory and subject matter experts. Aerospace Corporation operates the only federally funded research and development center committed exclusively to the space enterprise. This collaboration will allow companies to test and mature their technologies in a state-of-the-art lab" (AFRL, 2024). For the Orbital Prime's TRL Bootcamp, companies were paired with subject matter experts and lab capabilities from The Aerospace Corporation's Collaborative & Autonomous Vehicle Ecosystem (CAVE) lab. This facility and its staff provide capabilities to integrate and assess ISAM and more broadly Autonomy technologies simulated operational scenarios. The laboratory allows for hybrid hardware-, software-, and simulation-in-the-loop testing including testbeds purpose-built for operational scenarios such as autonomous spacecraft docking and servicing. The TRL Bootcamp team is currently engaged with SpaceWERX's Tactically Responsive Space (TacRS) cohort, with a wider range of technologies in the TacRS portfolio TRL Bootcamp is engaging subject matter expertise and laboratory facilities with additional national laboratories including partners from AFRL's Space Vehicles Directorate (AFRL/RV) with facilities tailored to not only the TacRS mission space but specific needs for closing TRL gaps within the cohort.

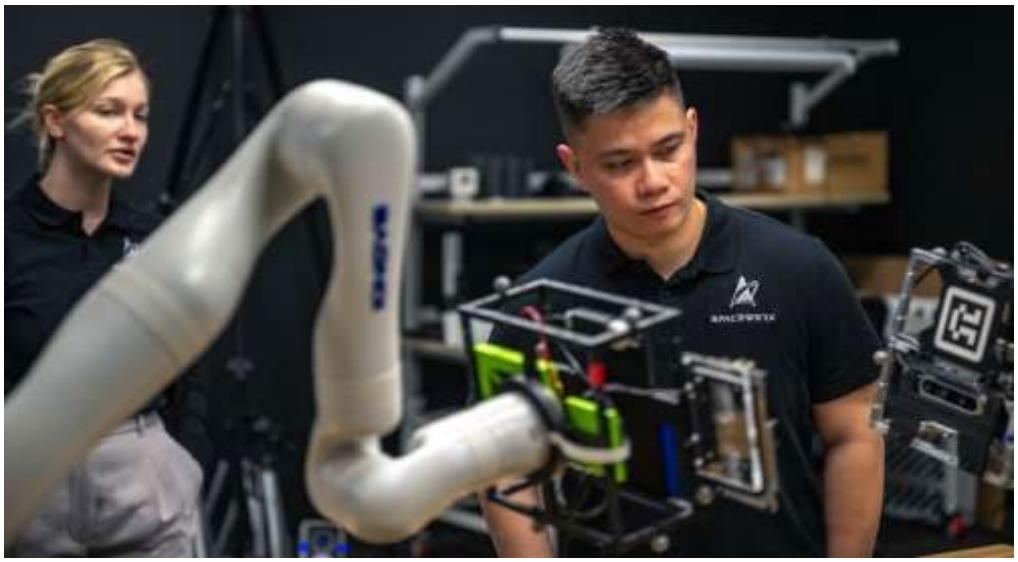

Figure 3. ***SpaceWERX Team at Aerospace Collaborative and Autonomous Vehicles Ecosystem (CAVE) Lab***

Early Indicators of Success

As of this writing, the program has been running less than 1 year, so results are still forthcoming. Nevertheless, early indicators suggest that "the discipline of TRL," including the close relationship to CONOPS, is beginning to have the desired effect. For example, we have seen where greater focus on mission CONOPS impacts company product development, which in turn brings greater alignment between small businesses and mission needs of programs offices within the USSF. The key to that progress is an improved understanding of how a small business's product and capability fits into a larger ecosystem. Also, by making available the precise subject matter experts and specialized test equipment, we believe we've seen faster technology maturation via targeted testing and analysis than otherwise would have been the case had the company been required to independently identify and schedule those services, or certainly acquire and create them internally. We have seen cohort companies form new partnerships and integrations, with the potential for greater levels of systems integration for customers and end-users. We are beginning to implement programs that access classified information to better inform commercial product development, in partnership with other Government labs like the Air Force Research Laboratory. We are starting to see the "brand" of TRL Bootcamp beginning to confer added credibility among the Government program managers we are interacting with when it comes to their perception of companies within a given TRL Bootcamp cohort. Lastly, lower TRL technology companies, technology developers at universities may see a "track" to Government program success and target the program accordingly.

These preliminary results are in the context of what in recent years has been a trend toward TRL becoming a kind of marketing banner, to be waved about, with little to no reference to the foundational nine levels and six factors that make up that scale. Through this program, we are working to spread the gospel of "Disciplined TRL" to partners, government agencies and commercial companies, including training and education on how other organizations can perform their own technical assessments following this framework. As one partner noted in a recent news article, *"BMNT works with the Aerospace Corp. to assess companies and their projects. We look at their technology readiness level ... because many of the companies are still research oriented companies*" (Space News, 2024). In short, greater TRL discipline means Government program managers can more accurately evaluate "time to fielding" of emerging technologies, creating greater adoption of innovation from the U.S. industrial base and more effective and efficient Government space programs.

Conclusion and Future Outlook

The TRL Bootcamp has demonstrated a measurable impact on military innovation, particularly in accelerating the maturation of commercial space technologies for the Space Force. Early results indicate significant improvements in identifying and addressing critical gaps in both technology development and capability alignment. Through rapid TRL assessments, the bootcamp provided companies with a structured roadmap to guide testing and validation efforts. These assessments enabled tailored support, including subject matter expert (SME) guidance, integration and testing assistance, and, in some cases, access to advanced modeling and simulation tools to deepen technical analysis. For small businesses lacking the resources, experience, or access to specialized software, this level of support was instrumental in achieving the necessary technical rigor to advance their technologies toward operational readiness.

In addition to technology maturation, a key success of the TRL Bootcamp was its role in helping participating companies refine their work plans and capability scopes to better align with mission needs. Many small and nontraditional businesses enter the defense sector with

innovative solutions but lack a clear understanding of how their technologies fit within the broader military space ecosystem. Through direct engagement with defense subject matter experts and partnering program offices within Space Systems Command, companies gained valuable insights into operational requirements and mission priorities. The bootcamp provided detailed guidance on typical CONOPS that should be utilized to shape their technology development and transition strategies. This structured approach enabled companies to better position their solutions to meet identified capability gaps, increasing their potential for successful integration into future Space Force programs. By equipping businesses with the necessary resources and knowledge, the TRL Bootcamp has enhanced the ability of commercial innovators to contribute effectively to national security objectives.

Beyond these immediate successes, the TRL Bootcamp has established a scalable and repeatable framework for broader defense adoption of commercial innovations. Over the initial 9-month period, seven companies from a targeted mission area participated, refining both their technologies and their transition pathways into defense applications. The ongoing expansion of the program includes onboarding future cohorts with varying mission sets, incorporating a range of technologies at varying levels of maturity. By maintaining a structured process while adapting to new mission requirements and stakeholders, the TRL Bootcamp continues to enhance the DoD's ability to integrate cutting-edge commercial capabilities into national security operations. Looking ahead, this methodology has the potential to serve as a model for accelerating technology adoption across the broader defense ecosystem, fostering stronger partnerships between the military and the commercial sector to maintain the United States' competitive edge in space and beyond.

Remaining Challenges and Future Expansion

Finally, this program may serve as a model for how the federal Government can leverage its national labs to accelerate commercial technology development from startups, incubators, accelerators and small businesses. A franchise model could facilitate that adoption and would include a playbook and instructions for how to set up and run such a program for another Government agency or for an international partner Government.

To realize that ambition, it would serve to expand TRL Bootcamp into a joint, cross-domain initiative by incorporating technologies across air, cyber, maritime, land, and space domains. Strengthening partnerships with DoD laboratories, national research centers, and university-affiliated institutions would ensure broader access to technical expertise, specialized facilities, and mission-relevant testing environments. As the program grows, enhancing coordination between military branches and research entities will be critical to ensuring seamless technology transition and interoperability across domains. By building a scalable, DoD-wide model, TRL Bootcamp can drive faster, more efficient technology integration, strengthening the nation's defense innovation ecosystem.

Final Thoughts

This program is still too recent to provide insightful metrics on company success rates and follow-on contracts resulting from this program. Nevertheless, The TRL Bootcamp is showing early signs of success as a transformative approach for accelerating the transition of commercial space technologies into military applications. By integrating rigorous maturity assessments with government lab testing and industry collaboration, the program has provided a structured and repeatable model for identifying, refining, and advancing critical capabilities. The success of the initial cohort highlights the effectiveness of this approach in bridging the gap between innovative small businesses and the complex needs of the defense space ecosystem. As the program expands to new mission sets and technology areas, it will continue to enhance the DoD's ability to rapidly adopt and operationalize emerging commercial innovations. With its

scalable framework and mission-driven focus, the TRL Bootcamp represents a critical step toward strengthening national security through increased collaboration between the military and the commercial space sector.

References

Air Force Research Laboratory. (2024, April). *SpaceWERX, The Aerospace Corporation collaborate to guide technologies through the 'Valley of Death.'*

Bryce Tech. (2019). *Startup space: Investment in commercial space ventures*.

Bureau of Labor Statistics. (n.d.). *Entrepreneurship data* [Chart]. https://www.bls.gov/bdm/entrepreneurship/bdm_chart3.htm.

Center for Strategic and International Studies. (2024, October). *From the Space Age to the Anti-Satellite Age*.

Congressional Research Service. (2023). *Report on defense innovation*.

Defense Innovation Board. (2024, July). *Aligning incentives to drive faster tech adoption*.

Failory. (n.d.). *Startup failure business rates*. https://www.failory.com/blog/startup-failure-rate.

GAO. (2022). *Report on DoD acquisition challenges*.

NASA. (n.d.). *Technology readiness assessment best practices guide*.

National Security Space Association. (2022, February). *Leveraging commercial space capabilities for U.S. national security*.

The RAND Corporation. (2023a, September). *Leveraging commercial space services*.

The RAND Corporation. (2023b). *Strengthening the defense innovation ecosystem.*

Space Capital. (2024, Q4). *Space Investor Quarterly*.

Space Insider. (2023, November). *Countries with space programs*.

Space News. (2024, January 30). *Space Force's Orbital Prime program looking to turn R&D into commercial products*.

SpaceWERX. (2022, November). *Orbital Prime*.

U.S. Space Command. (2024, October). *Leveraging commercial space: USSPACECOM memo to industry*.

U.S. Space Force. (2023, August). *Guidance and procedures on system acceptance throughout the Space Force* (Space Force Instruction 13-604).

Acquisition Research Program
Department of Defense Management
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
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